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ITEMS CONSIDERED IN THE REVIEW

OF

SEWERAGE PLANS AND SPECIFICATIONS

SUBMITTED TO

THE STATE SANITARY WATER BOARD

JULY 1, 1939

DEPARTMENT OF PUBLIC HEALTH
Cooperating with Sanitary Water Board
ROLAND R. CROSS, M. D.
A. C. BAXTER, M. D., Director and Chairman

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Prepared by

Division of Sanitary Engineering

Stream Pollution and Sewerage Section

C. W. KLASSEN, Chief Sanitary Engineer

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INTRODUCTION

Since its creation in 1929, the State Sanitary Water Board has been carrying on an intensive campaign to prevent and abate the pollution of Illinois streams, and these activities have resulted in an unprecedented sewage treatment works construction program throughout the State. While the primary object of the Board is to eliminate stream pollution, it is equally interested in bringing about the installation of waste treatment facilities that are adequate in capacity, capable of affording a practical degree of treatment, economical to build, and suited to convenient, economical operation.

The aim of this bulletin is to acquaint engineers engaged in the design, construction and operation of sewerage works with the details given particular consideration when plans are submitted to this office as basis for the permit required by law. The statements offered here are not intended as regulations or requirements, since it is fully appreciated that every problem requires individual study and considerable exercise of judgment by the engineer. Neither is it intended that progress in the development of new sewage treatment methods and equipment be stifled, although experimentation at the risk and expense of any municipality obviously must be prevented.

The bulletin is offered as a guide to designers, setting forth our opinions as to current approved practice and our suggestions regarding many of the details of design. Experience with many operating plants through frequent inspections, monthly reports and contact with operation personnel places this office in an excellent position to observe and study nearly all types of structures and equipment and by this bulletin we hope to bring about avoidance of past mistakes and to take advantage of proven devices which are known to be satisfactory.

A well-designed and efficient sewage treatment works reflects credit to everyone participating in the design, construction and operation. If this bulletin aids in the provision of such facilities, its purpose will be realized.

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SANITARY WATER BOARD

AN ACT *to establish a sanitary water board and to control, prevent and abate pollution of the streams, lakes, ponds and other surface and underground waters in the State.* [*Approved June 25, 1929. In force July 1, 1929. L. 1929, p. 386.*]

Be it enacted by the People of the State of Illinois, represented in the General Assembly:

SANITARY WATER BOARD—MEMBERS, TECHNICAL SECRETARY, MEETINGS.] § 1. There is hereby created and established a sanitary water board consisting of the Director of the Department of Public Health; the Director of the Department of Agriculture; the Director of the Department of Conservation; the Director of the Department of Purchases and Construction* and a representative of the manufacturing interests of the State to be appointed by the Governor who shall hold office for four years or until his successor shall have been appointed and qualified. The director members of the board shall receive no additional compensation for their services as members of the board other than that provided by law or by appropriation by the legislature for their respective positions as directors of State departments. The member appointed by the Governor shall receive no compensation for his services, but he shall receive necessary traveling expenses for any meeting of the board or for trips which he may make in connection with the work of the board, which traveling expenses shall be paid out of the regular traveling appropriations made to the respective departments.

The sanitary water board shall hold at least six regular meetings each calendar year at the office of one of the members and at times to be fixed by the board. The board shall select at its first meeting following the passage and approval of this Act, one of its members to serve as chairman and at the first regular meeting in each calendar year thereafter the chairman for the ensuing year shall be selected. The chief sanitary engineer of the Department of Public Health shall serve as technical secretary of the board. He shall receive no additional compensation for such services and during the interim between meetings of the board he shall handle such correspondence, make or arrange for such inspections and investigations and obtain, assemble or prepare such reports and data as the board may direct and authorize. Special meetings may be called by the chairman or by two members of the board by delivery of written notice at the office of each member of the board. Three members of the board shall constitute a quorum.

POWERS AND DUTIES OF BOARD—POLLUTION DEFINED.] § 2. It shall be the duty of the sanitary water board to study, investigate, and from time to time, determine ways and means of eliminating from the streams and waters of the State, so far as practicable, all substances and

* Now Director of Public Works and Buildings by Act approved June 20, 1933 to amend sections 3, 4, 5, 6, 7, 9, 13, 28, 36, 40, 49, 50, 51, 52, 56 and 58 of "The Civil Administrative Code of Illinois."

materials which pollute, or tend to pollute, the same, and to determine methods, as far as practicable, of preventing pollution that is detrimental to the public health, or to the health of animals, fish, or aquatic life, or detrimental to the practicable use of the waters for recreational purposes.

For the purposes of this Act, pollution shall be regarded as existing in any of said waters, if, as the result of any discharge of any liquid or solid substances, the quality of any of said waters, after reasonable treatment, is impaired for public water supply, bathing or recreational purposes, if said waters were reasonably capable for use for public water supply, bathing or recreational purposes before the discharge occurred of which complaint has been made to said sanitary water board; or, if obnoxious odors result from such discharge into any of said waters near buildings, roads and lands occupied or used by human beings, *provided* that odors shall not be deemed to be obnoxious in any case where the sanitary water board has determined that the discharge causing such odors does not constitute pollution within the meaning of this Act; or, if the quality of any said waters is impaired for the use of live stock, or kills, or is injurious to fish life, when said waters were reasonably practicable for use for watering live stock or for fish life.

The sanitary water board shall have the right to decide and define where such pollution exists and it is hereby given exclusive jurisdiction for that purpose.

"Sewage," etc., defined.] § 3. "Sewage" as used in this Act includes the water-carried wastes created in and conducted away from residences, public buildings, institutions, industrial establishments or any buildings in which such wastes are produced, together with such underground, surface and storm water as may be present. "Sewerage system" as used herein includes all structures, conduits, pipe lines and treatment works by which sewage is collected, carried or treated and discharged except the plumbing systems inside buildings and the drain pipe from buildings to street sewers.

Permit required for installation of or change in sewerage system.] § 4. No sewerage system which proposes to discharge into any of the aforesaid waters sewage or any other liquid or solid substance of a decomposable or putrescible, acid or other character, which may cause pollution of any of the aforesaid waters of the State, shall be installed until a written permit for such sewerage system has been granted by the sanitary water board. No changes, additions or extensions to any existing sewerage systems discharging into any of the aforesaid waters, including changes or additions to or extensions of the method of treating or disposing of the sewage, shall be made until plans for such changes, additions or extensions shall have been submitted to and a written permit obtained from the sanitary water board. *Provided, however,* that no permit shall be required for any new sewer system or changes or additions to or extensions of existing systems that receive or may receive only domestic or sanitary sewage from a building housing or occupied by fifteen persons or less.

PLANS AND SPECIFICATIONS TO BE SUBMITTED BEFORE PERMIT ISSUED.] § 5. Plans and specifications for any sewerage system covered by this Act shall be submitted to the sanitary water board before a written permit may be issued and the construction of any such sewerage system shall be in accordance with said plans and specifications. In case it shall be necessary or desirable to make material changes in such plans or specifications, revised plans or specifications, together with the reasons for the proposed changes shall be submitted to the sanitary water board for a supplemental written permit.

MAY REQUIRE OWNER OF SEWERAGE SYSTEM TO SUBMIT PLANS.] § 6. The sanitary water board may require any owner of a sewerage system discharging into any of the aforesaid waters to file with it complete plans of the whole or of any part of such system and any other information and records concerning the installation and operation of such system.

PROCEDURE FOR REVIEW OF PLANS.] § 7. The sanitary water board shall have the right to establish procedure for the review of any plans, specifications or other data relative to any sewerage system, written permits for which are required by this Act, and may make use of such assistance for such review as existing State departments and divisions may be able to render.

RULES FOR SUBMISSION OF PLANS.] § 8. The sanitary water board shall have the right to adopt and enforce rules and regulations governing the method and manner under which plans, specifications or other data relative thereto shall be submitted for sewerage systems or for additions or changes to or extensions of such systems.

ORDER TO DISCONTINUE DISCHARGE — NOTICE — HEARING.] § 9. Whenever the sanitary water board shall determine that sewage or any other liquid or solid substance of a decomposable or putrescible, acid or other character, is being discharged into any of the aforesaid waters and when, in the opinion of the sanitary water board, such discharge causes pollution as defined by this Act, the sanitary water board may order whomever causes such discharge to show cause before said board why such discharge should not be discontinued. A notice shall be served on the offending party directing him or it to show cause before the said sanitary water board, on a date specified in such notice, why an order should not be made directing the discontinuance of such discharge. Such notice shall specify the time when and the place where a public hearing will be held by the sanitary water board and notice of such hearing shall be served personally or by registered mail at least ten (10) days before said hearing; and in the case of a municipality or a corporation such service shall be upon an officer thereof. The sanitary water board shall take evidence with reference to said matter and may issue an order to the party responsible for such discharge, directing that within a specified period of time thereafter such discharge be discontinued unless adequate treatment works shall have been installed or existing adequate treatment works be properly operated.

REVOCATION, MODIFICATION OF PERMIT.] § 10. Any permit authorized and issued under the provisions of this Act may, when necessary, in the opinion of said board, to prevent or abate pollution of any of the aforesaid waters, be revoked or modified by the sanitary water board after investigation, notice and hearing, as provided in section nine of this Act.

INVESTIGATION OF SANITARY QUALITIES OF WATERS.] § 11. The sanitary water board shall have power to examine and investigate the sanitary quality of and establish standards of purity for any of the aforesaid waters and for those purposes the members thereof or its employees or representatives may enter and cross all lands in this State without doing damage to private property.

CONTINUED POLLUTION TO BE CONSIDERED NUISANCE.] § 12. If the pollution of any of the aforesaid waters within the meaning of this Act is continued contrary to orders of the sanitary water board, it shall constitute a nuisance which may be abated in actions commenced and maintained by the Attorney General in the name of the People of the State of Illinois in the manner in which other nuisances are abated.

FILING COMPLAINT OF POLLUTION.] § 13. Whenever any complaint of pollution of any of the aforesaid waters shall be filed with the sanitary water board it shall be the duty of the board to have such engineering, analytical, bacteriological, chemical, biological and other studies made as may be necessary, and if the pollution is found to exist, it shall be the duty of the sanitary water board to proceed as provided in this Act.

PENALTIES.] § 14. Whoever violates any provisions of this Act or fails to comply with any order of the sanitary water board in accordance with the provisions of this Act shall be fined one hundred dollars ($100.00). Each day's continuance of such violation or failure shall constitute a separate offense. The penalties provided in this section shall be recoverable by the People of the State of Illinois upon the suit of the Attorney General as debts are recoverable at law.

MUNICIPALITIES MAY INSTALL OUTLETS FOR SEWAGE SYSTEMS.] § 15. Cities, villages and incorporated towns shall have power to install and maintain outlets, discharging into the aforesaid waters, for sewage systems constructed prior or subsequent to the taking effect of this Act and subject to the provisions of this Act.

ACT NOT TO AFFECT CERTAIN SANITARY DISTRICTS.] § 16. Nothing in this Act contained shall apply to or be construed in any manner to affect the property, real, personal or mixed, wherever situated, or the channels, adjuncts and additions, drains, ditches and outlets, and their use, operation and maintenance and the right to the flow of water therein, and in rivers, streams and navigable waters connected thereto, for sewage, dilution, nor affect the jurisdiction, rights, powers, duties and obligations of any existing sanitary district which now has a human population of one million or more within its territorial limits.

PARTIAL INVALIDITY.] § 17. If any section, subdivision, sentence or clause in this Act shall be held to be unconstitutional, the unconstitutionality thereof shall not affect the remaining parts of this Act.

ITEMS CONSIDERED IN THE REVIEW OF SEWERAGE PLANS AND SPECIFICATIONS SUBMITTED TO THE STATE SANITARY WATER BOARD

The following comments, suggestions, and recommendations are offered to acquaint consulting engineers with the items given consideration in the review of sewerage plans and specifications which are submitted in accordance with Sections 5, 6, 7, and 8 of the sanitary water board law. Section 4 of the law provides that a permit is required for any installation of or change in a sewerage system. It is hoped that this bulletin will facilitate the preparation, submission, and our review of such plans and specifications.

It is not intended that the statements made herein are to be construed as rules and regulations. Every sewerage or sewage treatment problem has certain aspects which require that the engineer exercise judgment and initiative. This pamphlet lists the detailed design items with which this Board is concerned, with a brief discussion regarding each, setting forth our opinions as to good engineering practice.

Extra attention to details during design of sewerage works will result in increased efficiency of operation. The designing engineer must make it possible for the plant operator to make adjustments to meet variable operating conditions. If the designing engineer will place himself in the position of the plant operator, he will be most likely to conceive structures providing the utmost in flexibility and operating convenience. Details affording added flexibility usually do not involve material increases in cost of construction and often result in major operating economies to the community served.

PROJECTS NOT REQUIRING PERMIT

No permit from the Sanitary Water Board is necessary for strictly storm water sewers or for any sewer or treatment works that receives or may receive domestic or sanitary sewage from a single building housing or occupied by fifteen persons or less, unless industrial wastes are involved.

When storm sewers are proposed in an area not served by sanitary sewers, a copy of a municipal ordinance prohibiting discharge of basement and sink drainage, septic tank and cesspool effluents, or other polluting substances thereto must be submitted with the plans.

PRELIMINARY REPORT

Intelligent consideration of a sewerage project is possible only when the consulting engineer is authorized by the municipality to prepare a preliminary report based on a careful and complete field survey. Such a report is valuable to the city officials in that it summarizes all of the

pertinent facts relating to the problem. It is also distinctly advantageous to the engineer because it affords this office an opportunity to discuss any special problems and to mention any indicated revisions before design of detailed plans is commenced.

A complete preliminary report should include coverage of all the following items together with any other relevant data pertaining to unusual problems:

1. Statement of problems.
2. Present and future areas to be served.
3. Population forecasts for basis of design.
4. Description of existing water and sewerage facilities.
5. Present methods of garbage disposal and possibilities of future disposal with sewage.
6. Character and quantity of sewage. (Latter based on gaugings.)
7. Character and volumes of industrial wastes.
8. Degree of treatment based on nature of outlet stream and of policy of Sanitary Water Board.
9. Comparison of available sites and types of treatment.
10. Detailed basis of design of sewers and treatment units.
11. Necessary maps and layout sketches.
12. Estimates of construction costs.
13. Estimates of operating costs.
14. Comparisons of methods of financing.
15. Engineer's recommendations in sufficient detail to facilitate procedure by municipality.

When an engineer has been definitely engaged to make a study, any pertinent information in the files of the Sanitary Water Board and Division of Sanitary Engineering of the State Department of Health may be obtained and the Department's laboratory facilities are available for necessary analyses.

SEWERS

No permit will be issued by the Sanitary Water Board for combined storm and sanitary sewers, neither for a new system nor for an extension to an existing system of that type, except where the improvement proposed is intended to relieve existing combined sewers without creating an increase in the pollutional load on outlet water-courses. Extensions to existing combined sewer systems should be planned for strictly sanitary sewerage service.

Sewage collection systems should be designed for conditions anticipated at least 40 years in the future. Sewers serving strictly domestic areas should have a capacity, when flowing full, of at least 300 gallons and preferably 350 gallons per day for each person ultimately to be served. Proper allowance must be made for appreciable volumes of industrial wastes.

No public sewer should be less than 8-inches in diameter, and slopes should be such that the velocity when flowing full or half full is not less than 2-feet per second based upon the Kutter formula with "n" valued at 0.013. The minimum grades for sewers from 8 to 30-inches in diameter satisfying the above requirements are tabulated herewith:

Sewer Diameter (Inches)	Grade (%)	Sewer Diameter (Inches)	Grade (%)
8	0.36	18	0.11
10	0.27	24	0.08
12	0.21	27	0.07
15	0.15	30	0.06

All sewer lines should be laid in straight alignment with uniform slope between manholes. Manholes are desirable wherever a change in diameter, direction, or slope occurs; at the upper ends of all sewer lines and at intervals of 300-feet where the diameter is less than 18-inches and 400-feet where the diameter exceeds 18-inches.

Inverted siphons should comprise two or more pipes having a minimum diameter of 6-inches. Such siphons should be provided with all necessary appurtenances for inspection, rodding, flushing and other maintenance. The head and pipe size should be such that a velocity of at least 3-feet per second will be maintained for the average dry weather flow.

Diversion channels and intercepting sewers serving existing combined systems should be so designed that 3 to 5 times the ultimate dry weather sewage flow will enter the intercepter before overflow takes place, the actual dry weather flow multiple being dependent upon the nature and usage of the outlet stream.

Sewer plans should always include a plat indicating the ultimate areas to be served by the system, the location of sewer lines, manholes, etc., and the diameter of each section. If possible, the plan should also show contours at suitable intervals to indicate the local topography. Other sheets should include profiles of the individual sewer lines upon which the ground and sewer invert elevations, sewer diameter, and slope are indicated.

Special structures such as creek crossings, siphons, and supporting cradles (through unusual soil formations) should be carefully and completely detailed. Cast-iron or other special types of corrosion resistant pipe should be used at creek crossings, siphons, and where sewer lines pass through water-bearing formations.

Particular attention should be accorded the specifications for laying and jointing sewers so as to minimize ground water infiltration. Excessive infiltration results in increased construction and operation costs of sewage treatment works and in upsets in plant operation which lead to some inefficiency in treatment. It is, therefore, extremely important that infiltration be minimized by thoroughly detailed specifications and rigid enforcement during construction.

SEWAGE TREATMENT WORKS

1. General Comments:
   a. *Design Data:* A summary of the basis of design, including information relative to population, sewage flow, and the capacities of the various plant units, etc., should be submitted with plans.

b. *Plans:* Detailed construction plans and specifications are required before a permit can be issued. If progress of any project will be facilitated, blueprints of pencil sketches will be given a preliminary review providing such prints are legible. It will be greatly appreciated if plans submitted are of reasonable and uniform size for handling and filing.

c. *Structural Details:* The review of plans for the State Sanitary Water Board does not include coverage of structural details. All final plans should be stamped by a licensed structural engineer before submission to this Board, in compliance with other state laws.

d. *Degree of Treatment:* The discharge, character, and usage of the outlet stream will govern the degree of treatment required for each specific problem. In general, complete treatment will be necessary, with effluent chlorination in some cases, to afford additional protection in streams used for recreation. Primary treatment will be considered in a very few instances on the larger streams where the usage is such that rigid pollution requirements are not necessary at this time. A provisional permit will be granted for such installations.

Delay and misunderstanding will be avoided if the engineer will contact this office relative to the degree of treatment required for any specific location before commencing a design.

e. *Type of Treatment:* The importance of careful studies upon which to base the choice of treatment units cannot be overemphasized. Topography, industrial wastes, power costs, plant location, and probable character of operation supervision are some of the important factors to be given consideration in choosing the type of treatment units. In the past, unwise selection of the type of treatment has resulted in the installation of plants requiring operation expenditures beyond the financing ability of some small municipalities.

f. *New Processes, Methods and Equipment:* The policy of the Sanitary Water Board is to place no obstruction in the path of progress in sewage treatment methods and equipment, but under no circumstances will experimental installations be permitted at the expense of any Illinois municipality. Any new development must have been thoroughly tested to the satisfaction of this Board in a full-scale installation under competent supervision before a permit for a plant including this process or equipment can be issued, unless the municipality is amply protected so that in case of failure any expenditure of public money will be refunded.

g. *Quality of Effluents:* "Complete" treatment plants employing biological processes (activated sludge, conventional

trickling filters, or sand filters) should be capable of producing an effluent having a 5-day biochemical oxygen demand not greater than 15 parts per million and containing not more than 30 parts per million of suspended solids. Such an effluent should also have a methylene blue stability of 10 days or more and should show evidence of nitrification. The above determinations should be made in accordance with the methods prescribed by Standard Methods of Water and Sewage Analysis, on representative, properly collected, composite samples.

Quality of primary treatment effluents cannot be properly prescribed in the same manner as has been stated above for "complete" treatment plant effluents. Effluents from partial treatment plants are best judged by the absence of settleable solids and by the percentage removal of suspended matter, B. O. D., etc.

Guarantees covering operation of mechanical equipment on which the quality of the effluent is directly dependent, such as mechanical aerators, should include the above requirements with provision for the rejection and removal of equipment found unsatisfactory. Where it is necessary to revise or rebuild permanent plant structures in order to accommodate other mechanical equipment after the original installation has been rejected, the guarantee should include provisions to cover the cost of the alterations. The Sanitary Water Board is interested in guarantees for power consumption only to the extent that the power requirements be low enough to permit the treatment works to be operated at reasonable cost and within the financial ability of the municipality.

Tests of completed plants to determine the operating efficiency will be supervised by the Division of Sanitary Engineering at the request of the engineer and municipality and, in some cases, the collection of samples and tests will be conducted by the personnel of that Division. The manufacturer of the equipment should be required to supervise operation of the plant during the test period and to instruct the operating personnel in the maintenance and proper use of the equipment.

h. *Plant Location:* To avoid local objections, a sewage treatment plant site should be located as far as practicable from present built-up areas, or areas which may develop residentially within a reasonable future period. To locate a plant in unnecessarily close proximity to a residential district places a serious handicap on the operating personnel. If a critical location *must* be used, then provision for odor and insect control should be included.

Plants should be located on ground which is not subject to flooding and which is readily accessible in all seasons. The highest outlet stream stage of record should be noted in the plans.

i. *Arrangement of Units:* The topography at the site usually governs the general location of the component parts of the plant but operation, convenience, and flexibility should also be considered in developing the layout. The location of future units should be indicated in the plans.

An outside piping diagram with all lines *labeled* is essential.

j. *Industrial Wastes:* All unit capacities discussed herein are based upon treatment of strictly domestic sewage. Where industrial wastes of consequence are involved, they should be considered thoroughly during design of the treatment works. If an industrial waste requires preliminary treatment before discharge to the treatment works, or if the waste is of such character that it should be excluded from the sewers, the engineer should so advise the municipality when the plans are submitted in order that the industry may be given notice to provide suitable disposal facilities for the troublesome wastes before the sewage treatment works are placed in operation.

Where it is intended to handle industrial wastes in the sewage treatment works, the basis of design must be modified in accordance with the strength, character, and volumes of the wastes, and this information should be included in the summary of design data submitted with the plans.

k. *Cross-Connections:* No piping or other connections should exist in any part of the treatment works which under any conditions might cause the contamination of a drinking water supply.

l. *Sewage Flow Measurement:* Equipment for measuring and recording the volume of sewage coming to the treatment works is essential for the intelligent and economical operation of the plant and for the maintenance of complete records.

m. *By-passes:* Properly located and arranged by-pass structures are essential to the intelligent operation of any sewage treatment works. It should be possible to by-pass any major plant unit while maintaining other units in service.

Overflow by-passes are usually necessary ahead of: (1) the first treatment unit; (2) pumps; (3) the secondary treatment units, especially where secondary treatment is by activated sludge. Raw sewage by-pass should preferably take place after screening.

n. *Drains:* It should be possible to completely drain each unit (except Imhoff tanks, and sludge digestion tanks in some cases) by gravity or pumping.

o. *Fences, Railings, Walkways:* Enclosure of the plant by a suitable fence will afford protection against vandalism, and accident or loss of life to trespassers. Handrails should

be provided around all open tanks where there is possibility of accidents to plant personnel or visitors.

Judiciously located walkways of adequate width will encourage proper maintenance of units requiring frequent skimming or similar attention.

p. *Construction Materials, Paints:* Nearly all parts of sewage treatment structures are subjected to unusual corrosive action due to the presence of hydrogen sulfide, grease, and similar corrosive agents. Accordingly, judgment is required in the selection of construction materials and development of paint specifications.

Wrought iron, cast iron, galvanized iron, and ordinary structural steels will be generally suitable if proper provision is made for painting. Special metals and alloys (aluminum, Duraloy, Everdur, bronze, etc.,) may be warranted for certain items such as weir plates, gratings, anchor bolts, regulating devices, stop gates, etc., although use of these materials will be somewhat restricted by the cost.

Space is not available here to discuss paints most suitable for use in sewage works. Advice of a competent and reliable paint manufacturer's representative should be sought, if needed.

Corrosive action will be minimized if dampness is discouraged by adequate ventilation facilities at pump pits, basements, valve chambers, etc.

q. *Channels, Piping:* Naturally, all channels and piping should be of adequate size to carry maximum expected flows without hydraulic interference at any treatment unit, yet they must not be of such size that deposition of solids will take place at low flows.

Valve and stop gate arrangements should be such that intermittently used piping and channels will not stand full of sewage or sludge. Bottom corners of channels should be filleted to prevent solids deposition.

r. *Laboratory Equipment:* A suitably equipped laboratory is a requisite to efficient operation control and adequate records at sewage works. Obviously, the laboratory facilities needed depend upon the type and size of the plant and itemized lists of equipment for various classes of plants are available upon request.

s. *Grading, Landscaping:* The finished grading should be such that steep terraces and embankments are avoided insofar as is practicable. Surface drainage should prevent surface water flow into tanks, filters, sludge beds, etc.

Some provision in the construction contract for landscaping is highly justified. Landscaping need not be elaborate and if properly done will not involve appreciable expense, yet may eliminate much objection by nearby residents.

t. *Water Supply:* An adequate supply of safe, potable water under pressure should be available for use in the laboratory and general plant maintenance. Conveniently located yard hydrants will encourage good operation and cleanliness.

2. Sewage Pumps:

Two or more pumps should always be provided at sewage pumping stations. For small installations the pumps are usually of the same capacity so that they can be alternated to equalize wear, with each pump of slightly greater capacity than the expected average design flow. In larger installations requiring more than 2 pumps, capacities should be suited to meet actual flow conditions. Sewage pumps should be of the single suction, "non-clog" type, and should be automatically controlled in operation.

Where sewage must be pumped at the treatment works, the pumps should be located after the primary settling units if the inlet sewer elevation and topography of the site permits. This allows economical partial treatment of storm flows (where sewers are combined) and assures primary treatment of sewage in case pumps must be taken out of service for any reason.

Sewage pumps should always be protected against screenable objects by means of bar or basket screens, shredding devices, or piping arrangements permitting by-pass of large objects around the pump. Where screens are located in deep pits, the arrangement for handling screenings should not require such unpleasant and arduous manual labor that proper attention by maintenance personnel will be discouraged.

Installation of pumps in a "dry well" or a separate pit from that receiving the sewage is recommended. Pumps should be at such elevation that a positive suction head will obtain at all times although operation may be satisfactory if the maximum suction head does not exceed 10 feet. A dependable drain is essential in the pump pit.

The "wet" or sewage receiving well should have a capacity between the high and low water levels of at least twice the capacity of the smallest pump in gallons per minute. Best operation can be expected if the pump operates between 4 and 10 minutes per cycle under ordinary flow conditions. Wet well floors should slope to sumps at the pump suction. Wet wells should be provided with emergency overflows, and should be easily accessible by means of an outside entrance, if possible. If the manhole is indoors, a tight, gasketed cover should be provided to prevent odors.

Complicated piping and valve arrangements should be avoided where possible. An inverted bell-mouth at suction openings will reduce possibility of premature loss of prime when the pump is operating, due to passage of entrained

air into the suction. Every precaution should be taken to prevent turbulence at these openings. Each pump should have an individual suction.

Where the drinking water supply is used for pump water-seals at packing boxes, the piping must be such that the connection is not direct, regardless of the number and arrangement of valves. Such a direct connection constitutes a hazard to the safety of the drinking water supply.

3. Screens and Shredders:

Bar screens or shredding devices are necessary at the inlet to all sewage treatment works to remove or reduce in size any objects and materials which might interfere with the operation of mechanical equipment or clog piping.

Automatic, mechanical cleaning equipment is required where the clear opening between bars is one inch or less. For manually cleaned screens, a clear opening between bars of 1¼ to 1¾ inches is customary. The total net area of clear openings between bars should be such that a velocity of at least two feet per second will be maintained if the sewage contains grit or one foot per second if the sewage received is strictly sanitary in character. A bar slope of 30° from the horizontal is desirable. It is essential that a screenings platform of ample area, arranged for convenient raking of the screen and provided with drainage for dewatering of screenings, be provided.

Location of manually cleaned screens in deep chambers or wells should be avoided wherever possible unless provision is made for convenient handling of screenings to the point of disposal. Where housed in the main service building, the screen chamber should be tightly partitioned and provided with ventilation.

Unless mechanical shredders are installed in duplicate, an auxiliary bar screen is necessary for emergency use.

4. Grit Chambers:

Grit chambers are required to precede settling and oxidation units wherever the sewage contains storm and surface waters.

At least 2 channels are necessary for non-mechanical grit chambers unless suitable provision is made for automatic by-passing of dry weather flows around a single-channel unit. A proportional weir or other means of velocity control is needed to hold the velocity in each channel at or near one foot per second at all times. A minimum length of channel of 30 feet is desirable. Provision for sufficient grit storage to meet specific requirements of the installation should be made in non-mechanical grit chambers.

Accurate velocity control and duplicate channels are not essential if mechanical equipment for removing and

washing grit is provided. Such units are usually designed to give velocities between 0.5 and 0.75 feet per second at the average design flow.

Special attention should be given inlet details, arrangements for removing and handling grit and dewatering facilities. If hydraulics permit, a small grit receiving and dewatering bed constructed similarly to sludge drying beds (see Section 8-a), will save considerable manual labor on the part of the operator.

5. Septic Tanks:

Septic tanks are considered obsolete and unsatisfactory for municipal sewage treatment works because of the low efficiency obtained and the difficulty in operation.

6. Imhoff Tanks:

(a) *Adaptability:* Imhoff tanks should not be used where industrial wastes which may create acid or sour conditions (milk plant, brewery, etc.), may be present in the sewage to be treated. They are also best adapted to use in the southern part of the State where winters are less severe.

Odors are more difficult to control where Imhoff tanks are used and this should be given consideration if the plant location is critical.

(b) *Settling Channels:* Based on the average design flow, the retention period when secondary treatment is by sand or trickling filters should be at least 2.5 hours. When preceding activated sludge units, a retention period of 1.5 hours is adequate.

Inlets and outlets should be arranged to effectively develop the full area of channels. Flow distribution baffles at inlets and scum baffles at outlets should be adjustable. Provision for reversal of flow is necessary in long tanks. Walkways should be provided so that the operator may safely and conveniently carry on skimming and scum control operations.

The walls converging to the slot should have a minimum slope of 5 vertical to 4 horizontal and the slot opening should be about 8 inches with an overlap of 6 inches.

(c) *Sludge Digestion Compartment:* The sludge volume may be computed below the uppermost point at which the full overlap at the slot is effective.

At least 2.5 cubic feet per capita of sludge storage capacity should be provided for the design population when secondary treatment is by trickling or intermittent sand filters. It is not customary to use Imhoff tanks with the activated sludge process, although where activated sludge units are added to an existing Imhoff tank, additional

sludge storage may be provided in a separate digestion unit (Section 7-C).

Sludge hopper floors should be sloped at least 1.5 horizontal to 1.0 vertical. With proper slopes here, flushing rings are not considered necessary and may result in water supply contamination through back-siphonage.

(d) *Gas Vents:* These openings should be at least 18 inches in width and should have an area at least 20 percent of gross area of the sludge digestion compartment.

(e) *Sludge Piping:* Where sludge withdrawal is by gravity, the net. static head on the pipe must be at least 5 feet. Such piping should be 8 inches in diameter and arranged for rodding and draining. Repairs will be facilitated if valves are located outside the tank.

Bends in sludge piping should be minimized insofar as possible and cleanout openings provided for correcting clogging.

7. Separate Sedimentation and Digestion Tanks:

(a) *Primary Sedimentation Units:* The detention period in separate sedimentation tanks should be at least 2.5 hours when preceding sand or trickling filters and about 1.5 hours when activated sludge treatment is employed. Inlet and outlet details should be designed to prevent short-circuiting. Flow distribution baffles at inlets and scum baffles at outlets should be adjustable.

Mechanical sludge collection equipment is essential for best operation of separate sedimentation tanks. The use of plain, hopper-bottom tanks will be considered only when available funds absolutely preclude all possibility of the inclusion of sludge collection equipment. When plain, hopper-bottom tanks are necessary, the hopper slopes must be at last 60 degrees from horizontal and the effective detention period computed above the hopper.

Special facilities for skimming and handling scum are highly desirable. Safe and conveniently located walkways are necessary when skimming must be done manually.

Units equipped with mechanical sludge collectors should be at least 7.0 feet deep.

(b) *Sludge Pumps:* Sludge pumps should be specified to meet the requirements of service and should be located where there will be positive head on the suction.

Provision for varying the rate of discharge is highly desirable.

It is essential that provision be made for sampling and visual examination of primary sludge during pumping, as this is important in settling tank and digester operation. An excellent method of accomplishing this is by employment of a sludge well, to which the sludge can be drawn from the primary tank by gravity and examined during withdrawal. Primary tank scum may also be dis-

charged to this well and pumped with sludge to the digestion tank. All openings into the well should be outdoors and control valves should be nearby.

When the sludge pump suction is directly connected to the withdrawal piping at the sedimentation tank, a 2-inch, quick-acting sampling valve, with a drain directly beneath, should be provided.

(c) *Sludge Digestion Units:* The practice of basing sludge digestion, storage and drying requirements on dependable analyses of the volatile and ash content of the sludge to be handled, is encouraged. Where definite data on the amount and character of sludge is not available, plans are checked on the basis of the following per capita volumes with some modification for large installations:

	Heated Tanks (Cu. ft. per Cap.)	Unheated Tanks (Cu. ft. per Cap.)
Primary sludge only.....	2.0	3.0
Primary sludge plus trickling filter humus...	2.5	4.0
Primary sludge plus waste activated sludge..	3.5	6.0

Unheated separate digestion tanks are subject to operation difficulties in cold weather and are not recommended for use in Northern Illinois. A combination of heated digestion capacity and unheated storage capacity in separate tanks is recommended for best results, although this may not be economically feasible in small installations. When storage units are provided, the heated digestion tank volume may be reduced to about 75% of the minimum values listed above.

Any sludge digestion or storage unit must be afforded insulation, by an earth embankment or other approved methods, to the overflow elevation. These structures should be located above the ground water level to avoid excessive loss of heat.

Flexible facilities for handling supernatant liquor are essential to good digester operation. Piping should permit withdrawal of supernatant at several levels with a trapped overflow to prevent the discharge of scum. It should also be possible for the operator to inspect the supernatant at several levels in order to determine the best point of withdrawal. Sampling piping furnished for this purpose should be at least 1½ inches in diameter. Supernatant piping should permit optional discharge to the raw sewage, sludge drying beds, or to lagoons, if these are available. Where separate digesters are used to augment Imhoff tanks, supernatant liquor may be discharged to the gas vents of the latter.

The raw sludge feed pipe should discharge to the digester at a distance not less than the radius of the tank from the point of supernatant removal.

Entrance to the digestion tank control chamber should preferably be by a side entrance at grade rather than by means of a manhole and ladder. These chambers should be well lighted, ventilated, and equipped with a water service and drain.

(d) *Gas Collection and Utilization:* Where digester gas is used for any purpose, every precaution should be taken to eliminate asphyxiation and explosion hazards.

All gas piping should be at least 2½ inches in diameter, insulated against low temperatures and laid on a substantial foundation to prevent settling subsequent to construction. Lines should be given a definite slope to condensate traps at all low points. Drains from float controlled condensate traps should be vented and carried outside of buildings. By-passes should be provided at all major items of equipment except flame traps. Pressure relief and regulating devices are required to prevent hazardous leakage and to afford proper utilization of gas. Suitable flame traps should be provided on gas lines to boilers, engines, or other utilization devices.

Gas-burning boilers, engines, etc., should preferably be located at ground level in a well ventilated room. Waste gas burners should be located at least 25 feet from any plant structure.

The use of explosion-proof electric fixtures, where gas may escape, is recommended.

8. Sludge Dewatering Facilities:

(a) *Sludge Drying Beds:* An area of 1 square foot per capita is necessary when secondary treatment is by trickling or sand filters, and 1.25 square feet per capita for activated sludge plants. A reduction of 0.25 square feet per capita can be made if drying beds are equipped with glass covers.

The filtering material should be at least 12 inches deep above the top of the underdrains, the media comprising graded gravel, ranging from about 2-inches in size around the underdrains to about ¼ inch in size at the top of the gravel layer, and about 4 inches of clean sand at the surface. Open-joint, vitrified, bell-and-spigot sewer pipe is best for underdrains, which should be laid on a definite slope to the outlet and spaced at about 10 feet on centers. If the plant elevations permit, sludge bed drains should discharge to the raw or settled sewage for further treatment.

The elevation and slope of the sludge delivery pipe to the beds should be such that the line will drain. Concrete splash slabs are necessary at the points of discharge to prevent movement of sand.

It is important that drying beds be laid out to facilitate removal of dried sludge. Provision of trackways to

permit entrance of trucks into these beds is common. Sludge beds should be located at an elevation above high outlet stream stages.

(b) *Other Methods (Vacuum Filters, Incineration, etc.):* When it is proposed to dewater sludge by means other than by drying beds, a detailed basis of the design should be submitted with the plans. Such equipment should be suitably guaranteed as to performance. See Section 1-f (New Processes, Methods, and Equipment).

9. Settled Sewage By-Pass:

It is very important that provision be made for by-passing all or any part of the sewage flow after passage through primary sedimentation units. To fully protect secondary treatment units when the operator may not be present, it is recommended that this by-pass structure be built as an overflow weir with a gate or valve arrangement permitting by-pass of the entire settled sewage flow when necessary. A fairly wide range of adjustment at the weir is desirable.

10. Intermittent Sand Filters:

(a) *Adaptability:* Present practice is to consider secondary treatment by sand filters only for institutional or municipal plants serving 1000 persons or less. The greater area required, difficulties in operation (particularly in winter), and cost considerations usually indicate secondary treatment by other methods to be preferable in larger installations.

While it is possible to operate intermittent sand filters during winter, considerable labor and constant attention are necessary and their use is not recommended where winters are severe.

(b) *Loading and Details:* With acceptable primary treatment, a maximum loading of 1500 persons per acre may be used in computing the area required. Two or more units are necessary to secure intermittent dosage.

The total depth of filtering material should be at least 36 inches, the lower portion of which, carried to a level surface about 6 inches above the top of the underdrains, should comprise clean gravel, graded in size from about ¾ inch around the underdrains to ¼ inch at the top. The remainder of the filtering material should be clean, washed sand having an effective size between 0.35 and 0.50 millimeter and a uniformity coefficient not greater than 3.0, although a thin layer of coarser sand may be used in the transition from the gravel to surface sand layer.

The dosing tank volume should be such that any filter bed will be covered to a depth of 1 to 3 inches by each dose and that no bed will receive more than 2 doses per

day. Siphons should have a discharge capacity, at minimum head, at least 100 percent in excess of the maximum rate of inflow to the dosing tank.

Troughs or piping used for distribution of the sewage over the filter surface should be so located that the maximum lateral travel is not more than 20 feet and provision should be made at each discharge port for adjustment of the flow. Splash slabs are needed at each point of discharge.

11. Trickling Filters:

(a) *Conventional Type:* It is deemed best that trickling filter sizes be based on the organic matter content of the applied sewage, loadings up to 400 pounds of 5-day B. O. D. per acre foot per day being considered satisfactory. Where representative, dependable analyses are not available for such computations, the filter volume may be based on a design population loading of 3500 persons per acre foot for strictly domestic sewage. Additional volume is necessary if industrial wastes of consequence are to be received for treatment.

The depth of stone should be not less than 5.5 feet nor greater than 7 feet, unless a greater depth is justified by an exceptionally strong applied sewage.

Filter media must be clean, hard, sound, crushed rock or gravel, free of porous spots and sufficiently durable to withstand 20 cycles of the sodium sulfate soundness test, in accordance with the sampling and laboratory procedures set forth in Manual of Engineering Practice No. 13, American Society of Civil Engineers. The material should be reasonably uniform in all dimensions. It is believed that 1½ to 2½ inch stone will give effective treatment with a minimum of surface clogging. Specifications should provide that not more than 5% shall pass a 1-inch circular opening. Oversize material may be used to an elevation of not more than 6 inches above the top of the underdrains.

Adequate underdrains of an approved type designed for this usage should be specified, with provision made for ample ventilation throughout the bed.

Fixed spray nozzles, revolving distributors, or other established methods of distribution of sewage over the filter surface, will be considered satisfactory. Bulletin 101 of the Pacific Flush Tank Company will be used in checking the hydraulics of dosing tanks, siphons, and fixed nozzle distribution systems. Revolving distributors generally require dosing tanks although raw or settled sewage pumping arrangements will sometimes assure proper and continuous distribution on filters, making dosing units unnecessary.

Where the location of trickling filters is critical from the standpoint of odor production, provision for chlorination is advisable. (See Section 13.)

(b) *"High-rate" Type:* This unit is considered to be in development at this time but will be given favorable consideration where the outlet stream affords liberal dilution or where supplementary "polishing" treatment by approved units is provided.

It is suggested that applicability of high-rate filters to any specific project be discussed with this office prior to preparation of plans.

(c) *Final Settling Tanks:* Trickling filter effluents must be passed through settling tanks before discharge to the outlet stream in order to bring about the removal of organic matter sloughed from the stone during periods of unloading.

A retention period of 1.0 hour for the average design flow of sewage is sufficient, although somewhat more capacity is desirable where a single dosing tank is employed with fixed nozzle distribution, since this arrangement causes extreme variations in rates of flow from filters. Settling tanks receiving high-rate filter effluents should provide a retention period of 1.5 hours.

Mechanical sludge collection equipment is highly desirable in final settling tanks but plain, hopper-bottom units can be used if available funds are limited. The retention period in hopper-bottom units should be based on the volume above the hopper, and the hopper sides should be sloped at least 45 degrees from horizontal.

General practice is to discharge final tank sludge or humus to the raw sewage but a piping arrangement permitting optional discharge directly to digestion units also, is recommended.

12. Activated Sludge:

(a) *Diffused Air Type:* For ordinary domestic sewage, given proper primary treatment (See Section 7-a), an aeration period of 6.0 hours, computed for the design flow plus 25% return activated sludge, is considered satisfactory. Compressors and air piping should be designed to supply from 0.5 to 1.5 cubic feet of free air per gallon of sewage for conventional spiral flow tanks or 0.5 to 1.0 cubic feet per gallon where mechanical paddle wheels are used to afford circulation.

The diffuser plate area should be such that air application will be from 1.0 to 3.0 cubic feet per minute per square foot of diffusion surface for the above range of compressor capacities. The design should permit drainage and convenient maintenance of diffusers. Present trend is toward use of plates having a permeability of 25 to 40.

Diffused air tanks are generally about 15 feet deep. Recent practice is to use channels up to 30 feet wide, with a minimum width-length ratio of 1 to 5. Bottom corners in aeration tanks should be filleted to eliminate low-velocity areas, and openings between units should be large enough to prevent excessive head losses during high flows. Velocities through ports should not exceed 0.5 foot per second.

Meters, for measuring air quantities, air pressure, activated sludge return, and waste, should be provided.

(b) *Mechanical Aeration Type:* An aeration period of 8.0 hours based on the design sewage flow plus 25% return sludge must be provided when mechanical aerators are employed.

The layout should permit series or parallel operation and should be such that any single unit can be removed from service without interference with the operation of others. Inlet and outlet openings should be liberal in area, arranged to discourage short-circuiting, and equipped with easily-operated, water-tight gates. Bottom corners in tanks and mixed liquor channels should be filleted.

The hydraulics of flow through aeration units and to final settling tanks should be such that the liquor surface in mechanical aerators will not vary more than 1 inch with the extreme variation in flow. This is most important.

Any aeration tank (regardless of type) should be equipped with a drain permitting complete removal of the tank contents.

(c) *Reaeration:* Aeration of the return activated sludge alone before discharge to the settled sewage may be beneficial where concentrated industrial wastes are received for treatment. Under such circumstances it is suggested that the layout permit the use of one or more units for reaeration of sludge. Effective reaeration of return sludge requires greater quantities of air than are needed for mixed liquor.

(d) *Final Settling Tanks:* In activated sludge plants, final sedimentation units should provide a minimum retention period of 2.5 hours with a surface settling rate less than 1200 gallons per square foot per day at the design flow. The water depth should be at least 8.0 feet, and mechanical sludge equipment should be provided.

The outlet weir length should be sufficient to give an overflow rate of not more than 5000 gallons per day per lineal foot. This usually requires the use of "H" weirs or similar arrangements in rectangular units.

Walkways, beams, launder troughs, or channels which are partially submerged in the settling tank should be sloped on the underside to prevent accumulation of septic solids beneath them.

(e) *Activated Sludge Return and Waste:* The activated sludge removed at final settling tanks is usually discharged to a sludge division box where measurement, inspection, sampling, and apportionment to waste and return can be accomplished. Piping should permit return of activated sludge to the settled sewage at a point beyond the settled sewage by-pass, and should permit optional discharge of waste sludge to the raw sewage or the sludge digestion units. Provision should be made for concentration of waste activated sludge before direct discharge to sludge digestion tanks.

(f) *Activated Sludge Pumps:* Pumps used for lifting activated sludge to the division box are usually of the centrifugal type and should be of such capacity that sludge may be returned at rates between 20% and 50% of the design sewage flow. Flexibility in discharge rates is desirable. Activated sludge pumps should preferably be installed in duplicate and located where a positive head will exist at the suction.

When activated sludge must be drawn from two or more final tank sludge hoppers, gravity withdrawal through slip or swing pipes to a common sludge pump suction well is recommended.

13. CHLORINATION:

(a) *Chlorinator Type and Capacity:* It is recommended that only solution-feed chlorination equipment be considered for sewage treatment plant service.

Where intended for effluent disinfection, the chlorinator should be of sufficient capacity to maintain a residual (by orthotolidine) of 0.5 p.p.m. after 15 minutes contact. For domestic sewage of ordinary strength, the following dosages will usually be satisfactory:

Type Treatment	*Dosage*
Primary sedimentation effluent...	18 p.p.m.
Trickling filter effluent.....	12 p.p.m.
Activated sludge plant effluent...	6 p.p.m.
Sand filter effluent.....	6 p.p.m.

When intended for odor control, provision for a dosage of 3 to 15 p.p.m. of chlorine to the raw sewage is recommended.

(b) *Contact Tank:* This unit should afford a retention period of 15 minutes for the average, design flow. Provision should be made for mixing of sewage and chlorine at the inlet end and the tank should be suitably baffled to assure complete contact and prevent short-circuiting. A drain is essential.

(c) *Installation and Appurtenances:* Chlorination equipment should be located in a heated room with ample

storage space for chlorine cylinders. A room partitioned from other parts of the service building is desirable.

Chlorine scales, and extra essential parts of the chlorinator, should be provided.

14. Chemical Precipitation:

(a) *Adaptability:* It is considered that certain outlet stream conditions justify the seasonal use of chemical precipitants to increase efficiency of primary treatment units. Such chemical precipitants may also be effective in augmenting overloaded treatment units and in preliminary treatment of certain industrial wastes.

(b) *Chemicals:* The plans and specifications should state the chemical or combination of chemicals which are proposed to be used.

Chemical feed devices should provide for a wide range of dosages to meet variable conditions. Ample chemical storage space, located and arranged for convenient handling of chemicals, should be made available.

(c) *Tank Capacities:* Provision should be made for rapid mixing of chemicals and sewage at the points of application, followed by gentle agitation or flocculation, the total mixing and flocculation period being at least 2.0 hours and a surface settling rate of less than 1000 gallons per day per square foot of surface area, based on the average design flow.

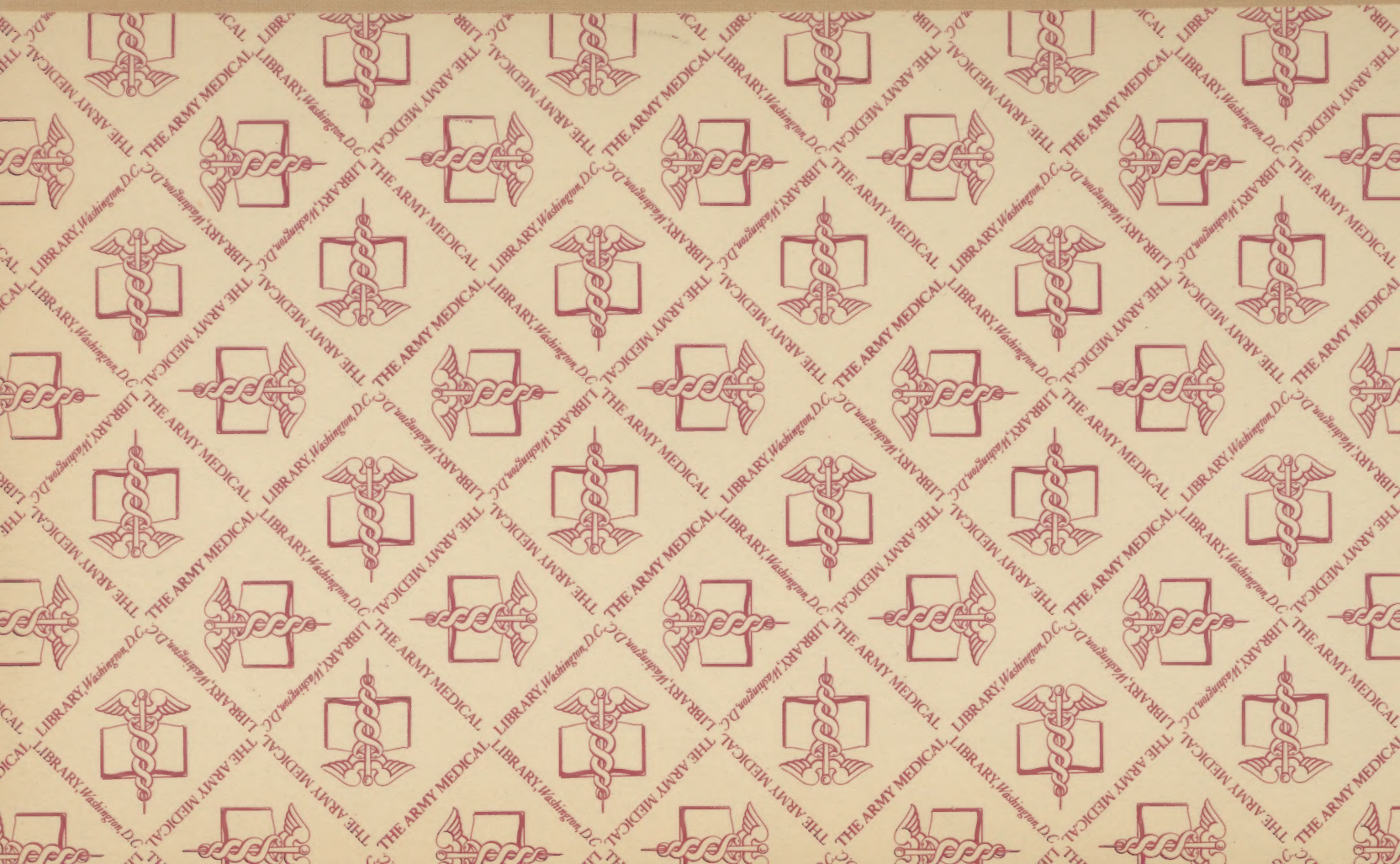
Velocities of flocculated sewage through pipes, channels, and ports should not exceed 0.5 foot per second.

Sludge digestion, storage, and drying requirements will be greater than for primary sludge alone, depending on the period of operation with chemicals. Sufficient data must be submitted by the engineer to indicate the basis for his design assumptions.

15. Changes Subsequent to Issuance of Permit:

The plans and specifications as finally approved are made a part of the permit. Therefore, any changes made after the permit is issued must be incorporated in revised plans and specifications and submitted for review and a supplemental permit.

It is requested that the engineer submit the names of manufacturers furnishing each item of equipment after final selection. This is particularly desired when plans provide for alternates.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